Restoration of Urban Waterways and Vacant Areas: The First Steps Toward Sustainability

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Increased population pressure and human activities have significantly altered the effectiveness of functions of ecosystems ("ecosystem services") at the local and regional scale. Of primary importance is the decrease in water quality due to urban storm water runoff. A number of communities have initiated restoration strategies to improve water quality standards. One such strategy is the incorporation of riparian walkways with native flora. As a result of such restoration efforts, habitats for native fauna have improved, and the number and diversity of wildlife have increased in urban settings. Restoration of urban habitats also provides social and economic benefits to the surrounding community. Efforts to mitigate the loss of ecological resources by restoring native habitats on lots that cannot be developed or on abandoned lots hold a high, unrealized potential. Habitat restoration not only provides natural diversions to urban surroundings, but also enlightens and educates individual citizens about the importance of balanced ecosystems and the role of humans within ecosystems. Education is the primary step toward creating ecologically sustainable communities. *Key words*: ecology education, habitat restoration, sustainability, urban renewal, waterways. *Environ Health Perspect* 103:452–453 (1995)

Most cities and towns have evolved along the banks and shores of waterways. Historically, the larger waterways functioned as major transportation corridors for humans as well as for other organisms. The numerous smaller waterways weaving through cities also functioned as sources of fresh water that provided food and habitat. Rapid urban expansion has dramatically changed the face of these waterways. Today, an estimated 93 million people reside in the coastal counties in the United States (*1*). Many water courses have been channeled, rerouted, paved over, transformed into storm sewers, or, in the case of wetlands, obliterated. Impervious surfaces, such as roofs, parking lots, roads, shopping malls, and industrial buildings, dramatically alter the flow of natural systems. Instead of percolating through the soil to groundwater aquifers or being transpired by vegetation, urban runoff shunted in abnormal patterns enters natural systems well beyond the urban areas from which the water originates. Additionally, the components of urban runoff, such as suspended solids, pesticides, nutrients, oil and grease, human and animal refuse, and pathogenic microorganisms, have significant impacts on the aquatic habitats they enter.

The National Research Council (*1*) estimates that approximately 85% of the 10 billion gallons per day of wastewater effluent discharged along the U.S. coasts enters bays and estuaries rather than open ocean. The ecological impacts of large-volume discharges into these slow-circulating habitats include sedimentation, anoxia, hypoxia resulting in aquatic plant die-back, and nuisance algal blooms, all of which adversely impact benthic populations such as shellfish. The Chesapeake Bay has seen dramatic declines in aquatic plant populations, which coincides with increased turbidity from agricultural and urban runoff. Aquatic plant communities are important nurseries that provide nutrients and shelter for molting crabs, juvenile fish, and shellfish, all of whose declines in the Chesapeake Bay are well documented. Residential, commercial, and industrial sites are all important contributors to urban runoff. Many of the contributing pollutants (such as refuse, oils, and solid materials) could easily be reduced with changes in urban lifestyle. With the water shortages we now face, particularly in the western United States, better management of water resources is mandatory. This can be accomplished while reacquainting urban dwellers with at least some of the attributes of natural systems.

The implementation of the 1972 Clean Water Act and its amendments in 1987 brought dramatic changes in point-source pollution, and society is only beginning to address the problems associated with nonpoint pollutants stemming from urban areas. Recognizing the importance of reducing nonpoint wastes, a number of creative and common-sense strategies have been developed. Unfortunately, no single "quick fix" or technology exists for reducing urban runoff, and a combination of innovative management policies and grassroots education is essential to improve water quality. Simple approaches, such as street sweeping and warnings posted on storm drains, may reduce urban pollutants, but to what extent is uncertain. In some cases, parking lot and gas station drains may be effectively retrofitted with oil and grit separators to remove hydrocarbons and heavy metals from storm water before its entry into storm sewers (*2*). San Francisco developed a combined sewer system in which all city water (including street runoff) is treated before its release (*3*).

The construction of wetlands to alleviate storm water pulses as well as to improve water quality is becoming increasingly popular. Wetlands (either engineered or natural), with dense vegetation and wide, shallow basins, slow the entry of storm water by forcing it to flow through a longer course (decreasing water velocity) and remain in the basin for a longer period of time so that trapping sediments is possible. Trapped sediments containing nutrients (such as nitrogen and phosphorus) are then used by plants during growing seasons or are broken down through biological processes such as denitrification. Wetlands have been extremely successful in reducing high pollutant loads in storm water. Samples from a constructed wetland in Auckland, New Zealand, reflect an 80–97% decrease in sediment concentrations of lead, total phosphorus, and hydrocarbons (*4*). In addition to improving water quality, wetlands serve as an attractive habitat for waterfowl and provide important ecosystem functions ("ecosystem services") to areas affected by urban development.

A number of cities are going beyond the banks of urban waterways to reduce urban runoff. Tucson, Arizona, is currently conducting a citywide storm water management study. This detailed analysis of the 59 watersheds in the city of Tucson is an effort to provide a long-range management plan for storm water quality and quantity. The plan promotes harvesting rain and grey water for landscape irrigation by private property owners and improved street and alley maintenance through increased street cleaning and waste removal. Tucson has a strict wash ordinance to protect washes from channeling and developing floodplains. Revegetation of disturbed floodplains and wash areas with native plant species is also encour-

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aged. In other areas, Tucson has created an extensive set of linear parks along its two major waterways, the Santa Cruz and Rillito rivers. Areas that were once graded and devoid of other vegetation are now lush with native mesquite (*Prosopis* sp.), palo verde (*Cercidium* sp.), ocotillo (*Fouquiera splendens*), and numerous small herbaceous plants. As a result of this endeavor, the linear parks are not only heavily used by humans (hiking and biking) but by native fauna as well. It is not uncommon to see horned lizards (*Phrynosoma modestum*), road runners (*Geococcyx californianus*), coyotes, and numerous species of birds and rodents foraging among the plants adjacent to the walkways. In addition to reducing urban runoff, the restoration of such disturbed riparian areas increases the opportunity for public environmental education. Surrounding businesses and residential areas also tend to benefit economically from similarly restored areas. The recent restoration of a downtown creek in San Luis Obispo, California, raised property values and enlivened business activity (*5*).

Strategies to reduce urban runoff have wide-reaching effects on community lifestyles and result in subtle improvements in the ecological condition of native plant and animal communities residing within the city. Integrated with strategies to decrease urban runoff are opportunities for urban ecological restoration. Urban ecological restoration need not be limited to riparian areas or wetlands. Although traditionally perceived as a linear process, urban development can be quite circular. Clothes, newspapers, and milk cartons are recycled; why not abandoned stores and empty lots? What would happen if abandoned or perpetually vacant commercial areas and empty lots were restored to natural habitat parks? As suburban malls, shopping strips, and housing developments continue to expand away from the city center, the remaining abandoned and vacant areas are ripe with restoration opportunities. The restoration of abandoned or vacant urban areas with native plant species may provide similar societal, as well as ecological, benefits as the community gardens and parks of the 1960s and 1970s. Urban restoration has the added benefit of reducing the impact of urban runoff, which is both a major ecological and societal problem (*6*).

The restoration of abandoned or vacant urban landscapes with native flora provides one means of replenishing ecological capital (e.g., fossil water and biodiversity). Additionally, revegetating graded areas and removing deteriorating buildings reduces suspended solids entering urban storm sewers. A number of valuable ecosystems already exist in heavily urbanized areas (e.g., Central Park, New York, and Amsterdam Bos, Holland) which further legitimizes the practice of environmental restoration in urban settings. Holland has pioneered the ecological restoration concept of landscape planning on a significant scale (*7*). Amsterdam Bos is a large, manmade forest. Bijlmereer is a 1960s housing project located on the flat polders southeast of Amsterdam. In England, volunteers from youth organizations and the Conservation Corps created the Ecological Parks Trust on two acres of abandoned warehouses and docks along the south bank on the Thames (*8*). Restored areas in close proximity (e.g., multiple lots on a city residential block) may function as habitat for small mammals, reptiles, and birds. Agencies such as state Game and Fish Departments and the federal Fish and Wildlife Service are establishing urban wildlife branches to determine the number and diversity of animal species residing in urban areas. These agencies also identify potential urban landscapes that may provide ecologically valuable habitat to nonhuman residents. On a subtle scale, all of these steps in ecological restoration represent steps toward sustainable use at the level of the individual.

To continue the trend toward sustainable resource use, society must pay attention to its influence at the level of the individual; its control of the rate of loss of ecological capital; overharvesting of renewable resources and exhaustion of non-renewable resources; deterioration of environmental quality; and extinction of species. First, the environmental literacy of most societies must be dramatically improved (*9*). The presence of restored floodplains, riparian zones, created wetlands, and grey water harvesting expose citizens to the environment at an approachable level. Second, society must understand what sustainability means. In its simplest form, sustainable resource use meets present needs without compromising the ability of future generations to meet their own needs. In fulfilling these needs, society must focus on both technological development and ecosystem services (*10*). Ecosystem services are those functions of natural systems perceived to be of value to human society, such as maintenance of water quality. Third, as identified by the National Research Council (*1*), integrated management strategies that identify the cost and consequences of resource use must be implemented. To achieve this goal, society must form a clear vision of the future of its communities and develop strategies toward that vision. It is essential that ecosystem protection and restoration measures be incorporated into the daily lives of individuals to maintain natural resources. In doing so, sustainable use practices may be realized.

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